Space Weather Technical Forecast

Issued on Monday 24 March 2025 at 13:14 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of G1/Minor geomagnetic storms throughout, with increasing probability by days 3 and 4 (26 and 27 Mar).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low in the past 24 hours, with occasional C-flares. The largest observed reaching C5.2 at 24/0737 UTC from a simple grouping AR4035 near centre disc There are six other regions on the Earth facing solar disc, the vast majority of which are relatively small and magnetically simple and either stable or in slight decay. AR4036, in the northwest quadrant, remains the most significant group, and appears magnetically simple.

No Earth-directed CMEs were observed leaving the Sun during the period.

Solar Wind / Geomagnetic Activity: Solar winds, as measured by DSCOVR at L1, were at slightly elevated levels with a spell of slow-ambient winds, and are currently around 410 km/s. Density was at near average levels. Interplanetary Magnetic Field, Bt, was weak, at 8nT or lower until the late arrival of an anticipated CME that left the sun on 21Mar with mostly Moderate levels observed for around 9 hours after 24/0000 UTC and a peak into strong levels reaching 17nT at 24/0114 UTC. The north-south component, Bz, was also weak, until the CME arrival when Moderate elevels were also recorded, ranging +13/-10nT. Phi angle was mostly negative (towards the sun). Geomagnetic activity was at Quiet to Active levels (Kp1-4).

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) at GOES18 was at background levels. High energy electron flux (greater than 2 MeV) was at background to moderate levels. The 24-hour fluence was below the Active threshold. The observed integrated pfu was 9.23e6 at 24/0000 UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Generally Low solar activity is expected, with a slight chance of isolated M-class flares over the next four days of the guidnace period.

Solar Wind / Geomagnetic Activity: A faint halo CME was observed leaving the sun at 21/1558 UTC from the southwest. This was initially forecast to arrive at Earth during 23 Mar, but may be slower with an arrival early on 24 Mar. There is a second CME, originating around 22/1400 UTC, which is of lower confidence. This CME may also be affecting Earth on Day 1. Solar winds at slow-

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ambient or slightly elevated levels probably reaching elevated to strong levels with the arrival of the HSS from a large coronal hole feature CH25/+ from late Day 2 or early Day 3 (26 Mar) onwards.

Quiet to Unsettled geomagnetic conditions with an increasing Chance of Active (Kp4) to G1/Minor storming following the CME arrival on Day 1 (24 Mar). There is a further chance of G1/Minor storms from late Day 2 (25 Mar) onwards due to the arrival of the HSS from CH25/+, and there is a likelihood of geomagentic storms to end the guidance period.

Energetic Particles / Solar Radiation: High energy proton flux is expected to be at background levels, with a slight chance of enhancement from any larger flares. High energy electron flux is expected to continue at largely background to moderate levels until later in the period, when it may become diurnally high. Electron (1e8 integrated pfu) fluence should remain below the Active threshold throughout the period.

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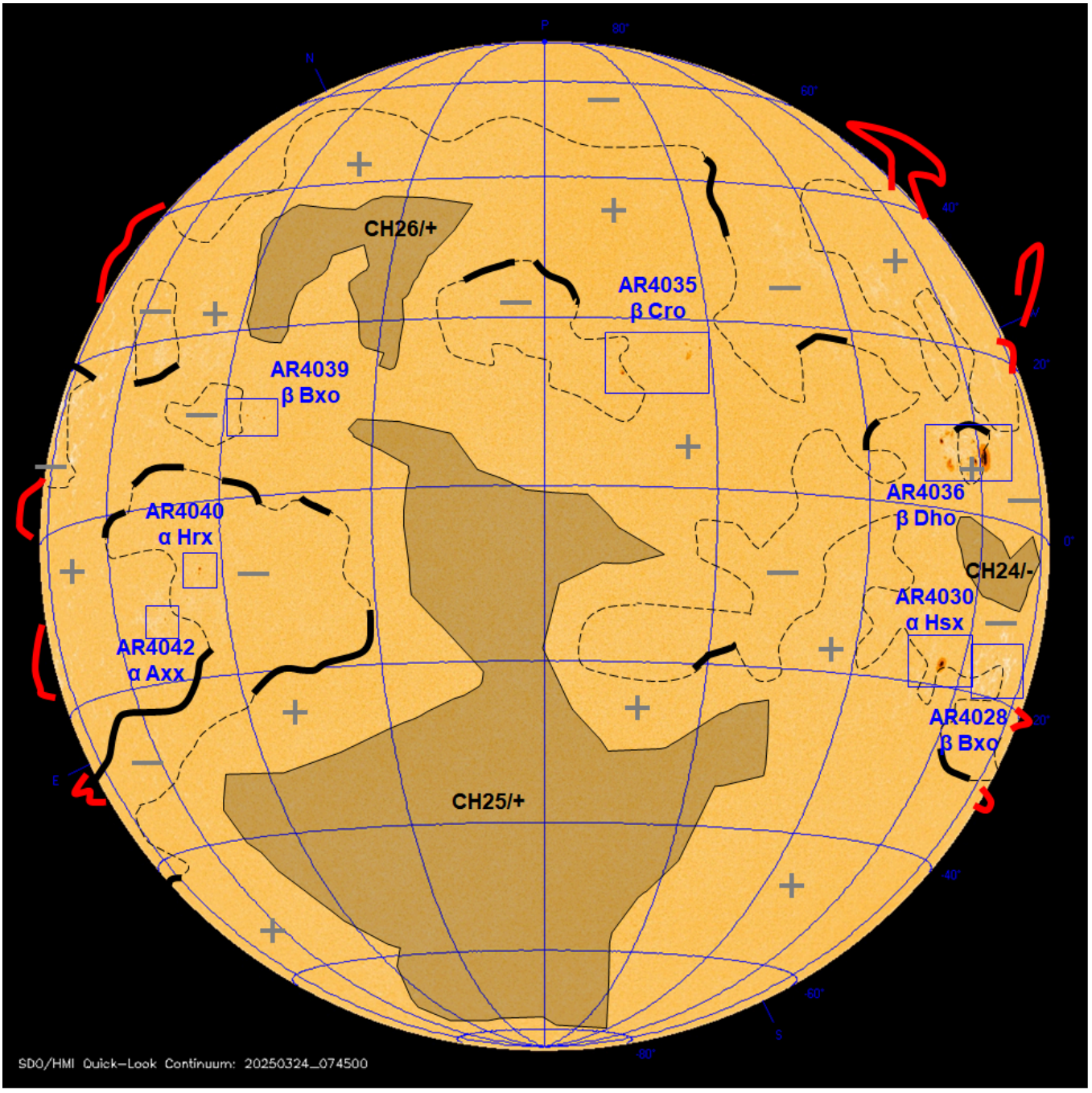
Figure 1: Solar Synoptic Map valid 24/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

Two CMEs feature in the forecast.

A faint halo CME was observed leaving near centre disc following the M1.2 flare from AR4028 at 21/1558 UTC. This was initially analysed as a fast CME with speeds in the region 800-1200km/s as it left the Sun, with an expected arrival at Earth on 23 Mar. This has probably now been observed and is slower than initially thought. There is a second CME, originating around 22/1400 UTC, which is of lower confidence. This CME may be associated with a small filament eruption near centre disk and was also at a similar time to two northern directed CMEs. Given the lack of STEREO-A imagery and the ability to triangulate this CME, it is not known for definite if this is a near or far-sided feature, and this may also have arrived on 24 Mar should it be near-sided.

Solar winds are at slightly elevated levels following the CME arrival as well as a waning CH influence from CH24/-. Solar winds may be at slow-ambient levels to start Day 2 (25Mar) before probably becoming enhanced to reach elevated to strong levels with the expected arrival of a HSS from the unusually prominent coronal hole feature CH25/+ from late Day 2 or early Day 3 (25-26 Mar) onwards. During the previous rotation solar winds exceeded 700 km/s for a time.

Quiet to Unsettled geomagnetic conditions with an increasing Chance of Active (Kp4) to G1/Minor storming following the CME arrival on Day 1 (24 Mar). There is a further chance of G1/Minor storms from late Day 2 (25 Mar) onwards due to the arrival of the HSS from CH25/+ and geomagnetic levels may reach G2/Moderate storm levels, partucularly during days 3 and 4.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	50	40	70	60
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R⊙ (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed (km/s)	Estimated Arrival Time (UTC)	Comments
21/1830	Full Halo	M1.2/Filament	Centre	1200	23/1400	Faint so unlikely to be material-rich, but fast and possibly enhancing already fast winds and disturbed near earth environment. Arrival still possible 24 Mar.
22/1810	Partial	Filament	Centre (possibly far-side)	1000	24/1200	Low confidence on lift off and lack of STEREO imagery so could be far-sided.

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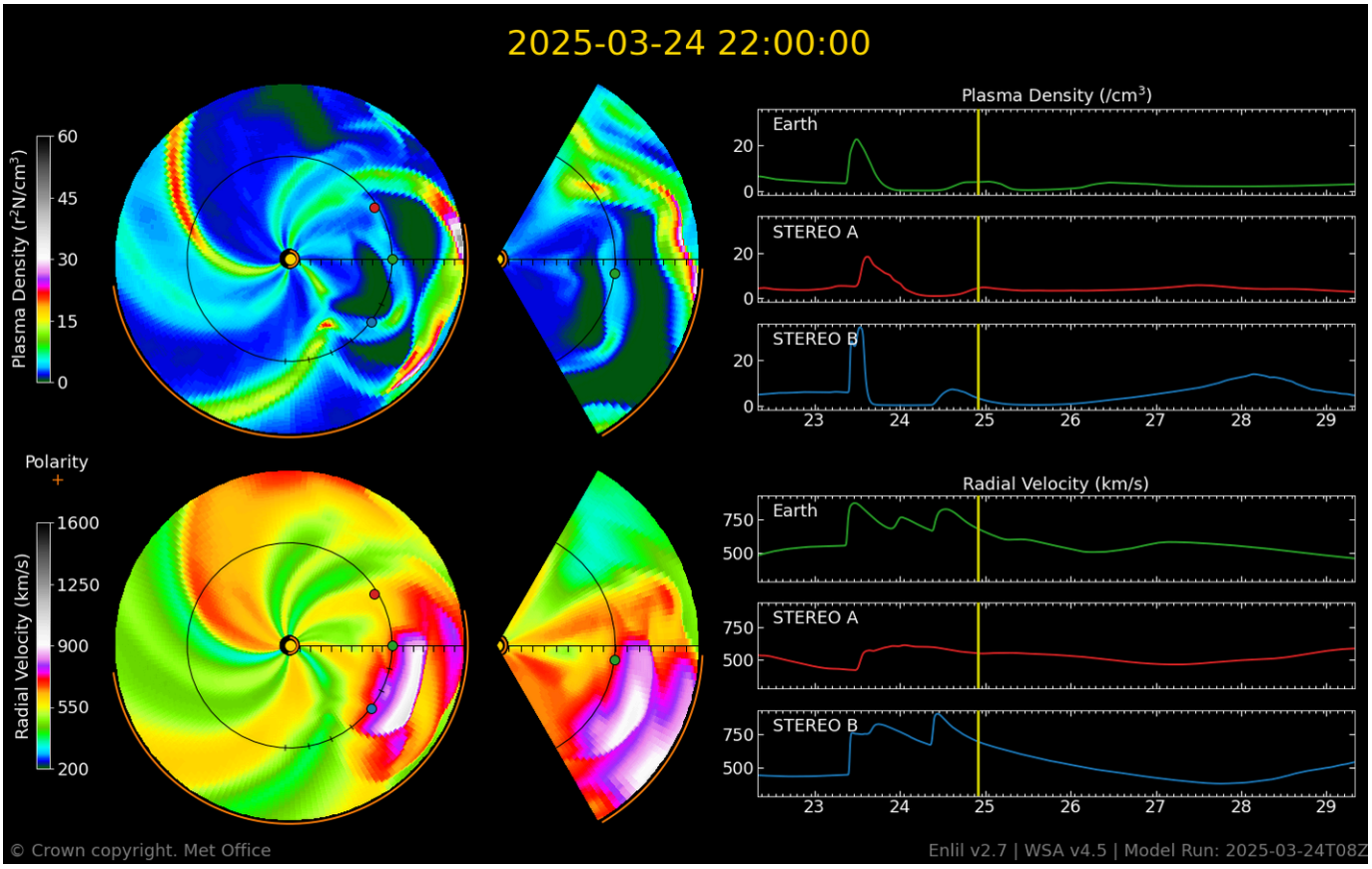
Figure 2: MOSWOC Enlil model. Note that CME arrival was probably slower than modelled.



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Radio Blackouts - X-Ray Flares

Solar activity has been Low in the past 24 hours, with occasional C-class flares.

Seven sunspot region cover the Earth facing solar disc, the majority of which are small and magnetically simple and either stable or in slight decay. AR4036, approaching the northwest horizon, is the largest grouping, has shown recent spot emergence and some re-organisation of the intermediate portion but remains magnetically simple.

Low solar activity is expected, with a slight chance of isolated M-class flares. The greatest risk probably coming from AR4036 in the northwest, however this wll rotate to the far side during this guidance period, and in the absence of further new active regions probabilities may fall further.

X-Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 (M Class)	No	15	10	5	10
Very Active	R3-R5 (X Class)	No	1	1	1	1

Figure 3: GOES-16 & 18 X-ray flux at GEO with C-class flares observed.

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Solar Radiation Storms (High Energy Protons)

GOES18 high energy (>10MeV) proton flux was at background levels. Proton flux is expected to remain at background levels, with only a slight chance of enhancement due to the current lack of large, complex spot groups on the Earth facing disc.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	5	5	1	1
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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High Energy Electrons (≥ 2MeV)

GOES16 High energy (>2MeV) Electron flux has been at background to moderate levels. With CH HSS influences expected through the period, flux levels will probably become diurnally high by Days 3 and 4 (26 and 27 Mar) and beyond.

MOSWOC REFM shows the electron fluence should remain below the Active threshold throughout the period, and is considered reasonable guidance with moderate confidence currently.

GEO Electron Environment Probability (Exceedance)	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ 2 MeV ≥ 1×10^{8}	No	1	1	5	10
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	1

Figure 4: High energy electron flux at GEO and Met Office REFM output.

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